DIVISION 5 – HOT MIX ASPHALT PAVEMENTS AND SURFACE TREATMENTS

NOTES

Section 501. Plant-Produced Hot Mix Asphalt

501.01. Description

This work consists of providing and placing hot mix asphalt (HMA) mix using Superpave mixture design methods.

A. **Definitions**

Binder Content. Percent by weight of asphalt cement in the total mixture.

Broken Aggregate. Cracked aggregate caused by construction operations.

Bulk Specific Gravity of Aggregate (G_{sb}). Ratio of the oven dry weight in air of a unit volume of an aggregate at a stated temperature to the weight of an equal volume of water at a stated temperature.

Crack. Visible fissure of varying length and orientation in the HMA, partially or completely through at least one course.

Effective Specific Gravity (G_{se}). Ratio of the oven dry weight in air of a unit volume of an aggregate (excluding voids permeable to asphalt) at a stated temperature to the weight of an equal volume of water at a stated temperature.

Flushing. Shiny or reflective condition, tacky to the touch, appearing on the HMA surface when asphalt binder collects in the voids at high pavement temperatures.

HMA Mix Design. Selection and proportioning of aggregates, mineral filler, reclaimed asphalt pavement (RAP), and asphalt binder to meet the required mix design criteria.

HMA Segregation. Areas of HMA pavement exhibiting non-uniform distribution of coarse and fine aggregate particles, visually or otherwise identifiable.

Job Mix Formula (JMF). HMA mix for a specific project, including adjustments to optimize the field application.

Lot. A lot is made up of a discrete tonnage of one mixture. A lot typically has five sublots (see definition of “sublot”).

Maximum Specific Gravity of Mixture (G_{mm}). Ratio of the weight in air of a unit volume of an uncompacted HMA at a stated temperature to the weight of an equal volume of water at a stated temperature.

Pavement. Completed HMA placement, including layers on driving lanes and shoulders.

Pavement Edge. Extremity boundaries of the pavement.

Roller Cracking. High-density surface map-cracking that appears immediately after rolling.

Rutting. Depression or displacement of the HMA surface that occurs in a longitudinal direction or a localized area.

Quality Assurance (QA). All activities dealing with acceptance of the product, including but not limited to materials sampling, testing, construction inspection, and review of Contractor quality control (QC) documentation. The Engineer's HMA QA procedures are contained in MDOT's *HMA Production Manual* and MDOT's *HMA QA Plan*.

Quality Control (QC). All activities dealing with process control to ensure quality, including but not limited to training, materials sampling, testing, project oversight, and documentation. For example, the Contractor's HMA QC procedures are contained in the Contractor's *HMA QC Plan*.

Sublot. Portion of a lot or an individual sample that is represented by a complete set of QA tests. Sublots are approximately equal in size at 1,000 tons. The Contractor and the Engineer may agree to reduce the typical 1,000-ton sublots based on project staging or other project conditions.

Target Value. JMF parameter value that may be adjusted, if approved by the Engineer, to account for changes in the physical properties of the mixture.

Temporary Pavement. Roadway and appurtenances constructed to help the movement of highway and pedestrian traffic around a construction operation that will be removed upon completion of the project.

Unlimited Daily HMA Production. Unrestricted daily HMA production tonnage.

Voids in Mineral Aggregate (VMA). Volume of void space between the aggregate particles of a compacted paving mixture that includes the air voids and the asphalt binder not absorbed into the aggregate, expressed as a percentage of the total volume of mixture.

501.02. Materials

Provide materials in accordance with the following sections:

Plant-produced HMA consists of asphalt binder, aggregates, mineral filler, and other additives.

Provide release agents that do not harm the HMA mixture. Do not use fuel oil or other distillate derivatives.

Provide the HMA mix type and the performance grade of asphalt binder as required by the contract.

Provide blended aggregates for HMA top course mixtures, except top courses for shoulders, bike paths, temporary roads, and parking areas, meeting the required Aggregate Wear Index (AWI).

A. Composition of HMA Mixtures

1. **Mix Design.** Develop an HMA mix design in accordance with the *HMA Production Manual* and submit to the Department. The Department will evaluate the design in accordance with Section 1 of the *HMA Production Manual*, “Procedures for HMA Mix Design Processing.”

   Provide written certification that the materials in the mix design are from the same source and meet the material properties in the mix design or the Department-approved JMF. Make all JMF adjustments in accordance with the *HMA Production Manual*.

   Provide combined aggregate blends meeting the properties specified in section 902. Provide a mix design that meets the requirements in Table 501-1, Table 501-2, and Table 501-3.

   For mix design purposes, top and leveling courses are the mix layers within 4 inches of the surface. The base course consists of the layers below 4 inches from the surface. For mix layers within the 4-inch threshold, if less than 25% of the mix layer is within 4 inches of the surface, the mix layer is a base course.

Table 501-1: Superpave Mix Design Criteria

Design Parameter	Mix Number			
	5	4	3	2
Percent of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d)	96.0%[(a)]			
%G_{mm} at the initial number of gyrations (N_i)	See Table 501-3			
%G_{mm} at the maximum number of gyrations (N_m)	≤98.0%			
Voids in mineral aggregate (VMA) min % at N_d (based on aggregate bulk specific gravity (G_{sb}))	15.00	14.00	13.00	12.00
Voids filled with asphalt (VFA) at N_d	See Table 501-2[(b)]			
Fines to effective asphalt binder ratio (P_{No200}/P_{be})	0.6–1.2			
Tensile strength ratio (TSR)	80% min			

(a) Unless noted otherwise on the plans, design all mixtures to 96.0% of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d). During field production, increase percent of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d) to 97.0%. Use liquid asphalt cement for regression of mixes unless otherwise noted on plans.

(b) For regressed mixtures the maximum criteria limits do not apply.

Table 501-2:
VFA Minimum and Maximum Criteria

Estimated Traffic (million ESAL)	Mix Type	Top and Leveling Courses	Base Course
≤0.3	EL	70–80%	70–80%
>0.3 – ≤3.0	EML	65–78%	65–78%
>3.0 – ≤30	EMH	65–78%[(a)]	65–75%
>30 – ≤100	EH	65–78%[(a)]	65–75%

ESAL = equivalent single-axle load

(a) The specified VFA range for mix Number 5 is 73–76%.

Table 501-3:
Superpave Gyratory Compactor Compaction Criteria

Estimated Traffic (million ESAL)	Mix Type	%G_{mm} at (N_i)	Number of Gyrations[(a)]		
			N_i	N_d	N_m
≤0.3	EL	≤91.5%	7	50	75
>0.3 – ≤3.0	EML	≤90.5%	7	75	115
>3.0 – ≤30	EMH	≤89.0%	8	100	160
>30 – ≤100	EH	≤89.0%	9	125	205

ESAL = equivalent single-axle load

(a) Compact mix specimens fabricated in the Superpave gyratory compactor (SGC) to N_d. Use height data provided by the SGC to calculate volumetric properties at N_i. Compact mix specimens at optimum P_b (percent asphalt binder content) to verify N_m for mix design specimens only.

If high-stress HMA is shown on the plans, provide the same mix designation (5EML, 5EMH, 4EML, 4EMH, etc.) as required for the mainline top and leveling courses, except change the performance-graded (PG) binder as shown on the HMA application table.

2. **Recycled Mixtures**. Recycled asphalt pavement (RAP) may be substituted for a portion of the new material required to produce the HMA mixture. Design and produce the mix to meet the criteria in this subsection and the contract.

    a. **Stockpile Requirements.** Process RAP to the size required for the specified HMA mix. Ensure the stockpile contains enough material to produce the recycled mixtures the Engineer approves for the project. If the RAP stockpile is not sufficient to produce recycled mix quantities required for the project, provide an Engineer-approved mix design without RAP at the same unit price.

    Provide documentation of testing (one test per 1000 tons, minimum of three tests) and accumulated tonnage in the stockpile to the MDOT laboratory. The tonnage may be estimated. The Department will begin evaluating the mix design after receipt of the documentation.

    b. **Mix Design.** Submit required documentation for recycled mix designs in accordance with Section 1 of the *HMA Production Manual*, “Procedures for HMA Mix Design Processing.”

B. **HMA Plant Certification.** Ensure HMA plants are certified by the Department at least 5 days before mix production begins. The Engineer will certify HMA facilities in accordance with Section 2 of MDOT’s *HMA Production Manual*, “Certification Procedure of HMA Plants.” Post a seal of certification in the plant control office.

C. **HMA Production.** Submit an approved mix design for the mix required to the Engineer at least 4 days before production begins.

Provide even heating of the mass of asphalt binders and maintain heat control. Heat asphalt binders to the temperature required for the type of binder. Do not exceed the maximum temperature specified in Table 904-7 for asphalt binder and HMA. The Department will reject asphalt binder and mix if the temperature exceeds the maximum specified in Table 904-7. The Department will reject contaminated asphalt binder.

Stockpile aggregates at the facility in a manner that prevents segregation. Dry aggregates to a moisture content that will ensure an appropriately coated HMA mix. For batch and continuous plants, the Department will reject aggregates in the hot bins that contain sufficient moisture to cause

foaming or a water-saturated mixture. Remove rejected materials from the bins.

Place uniform gradations of aggregates in the cold feed system. If providing a blend of aggregates for the mix by combining aggregates from at least two cold feed bins, ensure that the blend meets the combined gradation (from JMF) QC tolerances.

The use of at least one hot aggregate bin to proportion aggregates to meet the JMF tolerances is allowed if the cold feed requirements are met.

501.03. Construction

A. **Equipment.** Provide equipment in accordance with section 107, capable of producing pavement that meets the requirements of this section.

1. **Cold-Milling Machines.** Provide equipment that consistently removes the HMA surface, in one or more passes, to the required grade and cross section, and produces a uniformly textured surface. Provide machines equipped with the following:

   a. Provide a cold-milling machine that has sufficient power, traction, and stability to maintain an accurate depth of cut. Maintain the propulsion and guidance system of the milling machine in such condition that the milling machine may be operated to straight and true lines;

   b. Provide a cold-milling machine capable of operating using minimum 30-foot automatic grade controls (contact or non-contact) averaging system or other approved grade control systems and capable of transverse slope control. Describe the use of such controls in the Contractor's *Cold-Milling Quality Control Pla*n; and

   c. Provide a cold-milling machine capable of picking up the removed material in a single operation. A self-loading conveyor will be an integral part of the milling machine. Windrows are not allowed.

2. **Hauling Equipment**. Ensure that transport trucks are equipped to protect the mix from the weather and retard the loss of heat. Equip transport trucks and trailers with a working backup alarm.

3. **Pressure Distributor**. Provide a pressure distributor in accordance with subsection 505.03.A.1.

4. **Pavers.** Equip each paver with a full-width vibratory or tamper bar screed capable of spreading and finishing HMA to the required cross

section and grade. Use a paver that produces a uniformly finished surface, free of tears, other blemishes, and measurable segregation.

Equip the paver to provide a uniform head of material ahead of the screed. Install reverse pitch augers or paddles inside the ends of the auger shafts to force the mix to the center of the main screed.

Ensure that extensions added to the main screed provide the same vibrating or tamping action and heating capabilities as the main screed. Adjust extensions to the main screed so, after breakdown rolling, no longitudinal marks remain on the surface. Equip in-line screed extensions with a continuation of the automatically controlled spreading augers to within 12 inches of the outside edge. Follow the manufacturer's recommendations for other screed extensions.

Except for the paving operations listed in subsection 501.03.F.1.a through subsection 501.03.F.1.d, equip pavers with an automatically controlled and activated screed with grade reference and transverse slope control. Use an Engineer-approved grade referencing attachment, at least 30 feet long for lower courses and the first pass of the top course. Ensure that the Engineer approves alternate grade referencing attachments before use.

After placing the first pass of the top course, the Contractor may, with prior approval from the Engineer, substitute a joint matcher, a grade referencing attachment at least 10 feet long, or other grade referencing equipment for constructing adjacent passes of the top course.

5. **Rollers**

   a. **Steel-Wheeled Rollers.** Provide self-propelled vibratory steel-wheeled rollers, static tandem rollers, or self-propelled static three-wheeled rollers. Provide a steering device that allows the roller to follow the established alignment. Equip rollers with wheel sprinklers and scrapers. Provide smooth roller wheels, free of openings or projections that will mar the pavement surface.

      Provide vibratory rollers with an automatic shutoff to deactivate the vibrators if the roller speed decreases below ½ mph. Provide rollers that operate in accordance with the manufacturer's recommended speed, impacts per foot, and vibration amplitude for the thickness of HMA mix.

   b. **Pneumatic-Tired Rollers.** Provide self-propelled pneumatic-tired rollers. Equip rollers with at least seven wheels spaced on two axles so the rear group of tires does not follow in the tracks of the forward group, providing at least ½-inch tire path overlap. Provide

smooth tires capable of being inflated to the pressure recommended by the roller or tire manufacturer. Equip the rollers with a mechanism that can smoothly reverse the motion of the roller.

Equip the rollers with wheel scrapers and skirting to enclose the wheels to within 3 inches of the pavement surface. Use a release agent to prevent material from sticking to the tires and being deposited on the top course pavement during rolling.

c. **Combination Rollers**. The Contractor may use combination pneumatic-tired and steel-wheeled rollers manufactured specifically for HMA compaction, if equipped with the required sprinklers and scrapers.

6. **Spreaders**. Use self-propelled spreaders capable of pushing the hauling units. Ensure that spreaders can maintain the required width, depth, and slope, without causing segregation.

7. **Material Transfer Device**. When a material transfer device (MTD) is required, it must be capable of delivering HMA mix from the truck transport to the paver hopper to ensure constant paver speed, remixing HMA material using manufacturer's developed technology, and depositing material in the paver hopper. Provide a paver hopper insert with at least a 10-ton capacity in the paver and keep at least two-thirds full of mix during paving. A windrow pickup machine does not satisfy the requirements for an MTD.

8. **Compressed Air System**. If a compressed air system is required for cleaning pavement, equip the air compressor with a moisture separator to remove oil and water from the air supply. Provide a compressor capable of producing at least 100 psi and continuous 150 cfm airflow.

9. **Miscellaneous Equipment**. Provide a straightedge, at least 10 feet long, and other tools to finish the work.

10. **Lights on Equipment**. If maintaining traffic on HMA construction, equip equipment within the project, including cold-milling machines, distributors, and rollers, with at least one Department-approved flashing, rotating, or oscillating amber light. Equip pavers with at least one light on each side. Mount the lights so the warning signal is visible to traffic in every direction. Operate the lights while work is in progress. Ensure that hauling units activate four-way flashers on the project.

B. **Preparation of Base.** Provide subgrade, subbase, aggregate base course, crushed and shaped base, or rubblized base in accordance with the relevant sections of Division 2 and Division 3, before HMA placement.

C. **Preparation of Existing Pavement.** Prepare the existing surface as required to construct HMA pavements, shoulders, and approaches.

1. **Drainage Structures, Monument Boxes, and Water Shutoffs**. Adjust, temporarily lower, or both, catch basins, manhole covers, monument boxes, and water shutoffs in accordance with subsection 403.03.A. Meet the smoothness requirements required in subsection 501.03.H.

2. **Cleaning Pavement.** Using methods approved by the Engineer, clean dirt and debris from the pavement surface and paved shoulders before placing HMA. Remove loose material from joints and cracks using compressed air.

   If the Engineer determines the compressed air system will not remove deleterious material, remove loose material by a hand or mechanical method, as approved by the Engineer. The Department will pay for removal of material by hand or mechanical methods in accordance with subsection 501.04.E.

   Do not place HMA until the Engineer inspects and approves the condition of the existing pavement.

3. **Removing Existing Pavement for Butt Joints**. If a butt joint is required, remove the existing surface to the thickness of the proposed overlay for the full width of the joint. Uniformly taper the removal to the original surface over at least 35 feet.

4. **Edge Trimming**. For required removal of HMA shoulder material or no greater than 1 foot width of HMA pavement, cut the HMA material full depth along the pavement edge or removal line to prevent tearing the pavement surface. Cut joints, where the completed surface will be exposed, with a saw, cold-milling machine, or other methods approved by the Engineer. Cut joints, where the completed surface will be covered by HMA mix, with a coulter wheel, saw, cold-milling machine, or other method approved by the Engineer.

5. **Cold-Milling HMA Surfaces.** Before milling existing pavement, obtain a Department-approved mix design in accordance with subsection 501.02.A, and ensure the availability of HMA mix quantities to cover milled surfaces. Do not maintain traffic on the milled surface unless specified in the contract or approved by the Engineer.

Cold-Milling QC Plan and Cold-Milling Operations Plan. Prior to beginning milling operations, submit a *Cold-Milling QC Plan* and a *Cold-Milling Operations Plan* to the Engineer for approval.

a. Include, as a minimum, the following items in the *Cold-Milling QC Plan*:

   i. The schedule for replacing the cutting teeth;

   ii. The daily preventive maintenance schedule and checklist;

   iii. Proposed use of automatic grade controls;

   iv. The surface testing schedule for smoothness;

   v. The process for filling distressed areas;

   vi. The schedule for testing macrotexture of the milled surface;

   vii. Corrective procedures if the milled surface does not meet the minimum macrotexture specification;

   viii. Corrective procedures if the milled surface does not meet the minimum transverse or longitudinal surface finish when measured with a 10-foot straightedge;

   ix. The methods for longitudinal control guidance (painted string line or measure offs); and

   x. Contact information for on-site contractor personnel responsible for the work and authorized to adjust the QC plan.

b. Include, as a minimum, the following specific items in the *Cold-Milling Operations Plan*:

   i. Number, types, and sizes of mill machines to be used;

   ii. Width and location of each mill machine pass;

   iii. Number and types of brooms and or vacuum trucks to be used and their locations with respect to the mill machine;

   iv. Proposed method for mill machine and wedging around existing structures such as manholes, valve boxes, and inlets;

   v. Longitudinal and transverse typical sections for tie-ins at the end of the day;

   vi. If requested by the Engineer, a plan sheet showing the milling passes; and

vii. Names of macro-texture testing personnel and sequencing of testing (minimum of three tests daily that are representative of the day's milling).

Remove the HMA surface to the depth, width, grade, and cross section shown on the plans. Backfill and compact depressions resulting from removal of material below the specified grade, in accordance with subsection 501.03.C.9.

If the milling machine discovers buried structures within the specified grade, such as valve boxes, manholes, or railroad tracks that are not identified on the plans, the Department will pay for all associated costs, as extra work, in accordance with subsection 103.02.

Immediately after cold-milling, clean the surface. Dispose of removed material in accordance with subsection 104.07.D and subsection 204.03.

Mill the existing pavement to the cross slope shown on the plans. Supply a 10-foot straightedge. Ensure that the finished surface does not vary longitudinally or transversely more than ¼ inch from a 10-foot straightedge. Ensure that the milled area is free from gouges, continuous grooves, and ridges and has a uniform texture. Ensure that the horizontal gouge in the vertical edge created from the milling operation is limited to a maximum width of 1.0 inch. Adjust speed, drum speed, and/or teeth as necessary to meet the requirements of this specification. Ensure that the milling operation provides an acceptable surface texture by achieving a maximum mean texture depth of 0.108-inch thickness according to ASTM E965. Perform three random QA macro texture tests daily that are representative of the day's milling to maintain texture and verify conformance with the 0.108-inch thickness mean texture depth requirement. For projects with less than 3,000 square yards, a minimum of one random QA macro texture test per day is required. Perform tests as soon as practical behind the milling operations.

6. **Removing HMA Surface.** Except as specified in subsection 501.03.C.4, removing an HMA surface applies to removing HMA overlying a material designated for removal or that is required to remain in place.

   Cut joints, exposed in the completed surface, with a saw or cold-milling machine. Cut joints, covered by HMA mix, with a coulter wheel, saw, or cold-milling machine. Obtain the Engineer's approval of alternate methods for cutting joints.

When removing HMA overlying a base course that is to remain in place, cut the edges of the surface requiring removal along straight lines for the full depth of the HMA surface.

When removing HMA by cold-milling, the Engineer may direct removal to be less than the full depth of HMA surface.

7. **Removing HMA Patches**. Remove patches that may compromise the performance of the overlay.

8. **Joint and Crack Cleanout**. If the plans show joint and crack cleanout, use mechanical or hand methods to remove joint sealants to at least 1 inch deep. Remove vegetation, dirt, and debris that cannot be removed using the methods specified in subsection 501.03.C.2 from transverse and longitudinal joints and cracks. Use hand patching to fill cleaned joints and cracks at least 1 inch wide.

9. **Hand Patching**. If the contract requires hand patching, fill holes, depressions, joints, and cracks in the existing pavement and replace existing patches. Compact the hand patching material in no greater than 3-inch layers to the adjacent pavement surface grade using a machine vibrator or Department-approved roller. Use top course or other Engineer-approved mix for hand patching material.

10. **Repairing Pavement Joints and Cracks**. Repair joints and cracks as required.

D. **Bond Coat.** Uniformly apply the bond coat and provide complete coverage to a clean, dry, surface with a pressure distributor. Obtain the approval of the Engineer for the application rate after work begins. Application rate must be within a range of 0.05 to 0.15 gallons per square yard. Apply the bond coat ahead of the paving operation to allow the bond coat to cure before placing HMA.

Do not leave pools of bond coat on the surface and do not spray the bond coat on adjacent pavement surfaces. Apply the bond coat to each HMA layer and to the vertical edge of the adjacent pavement before placing subsequent layers.

E. **Transportation of Mixtures.** Weigh each load of HMA, accepted by the Department, to the nearest 20 pounds on an approved scale with an automatic printout system. Provide a scale and printout system for platform and suspended scales in accordance with subsection 109.01.B.6. Provide a ticket to the Engineer with each load.

Apply a release agent, in accordance with subsection 501.02, to hauling units. Loads with excessive amounts of release agent will be rejected. Do not place crusted HMA in the paver.

The Department will reject loads, immediately prior to placement, with a temperature either below 250°F (225°F when using a warm mix chemical additive) or greater than 20°F from the recommended maximum mixing temperature specified by the binder producer.

F. **Placing HMA**

1. **General**

Place HMA on a cured bond coat using pavers in accordance with subsection 501.03.A.4 unless placing mixtures for the following:

a. Variable width sections;

b. The first course of a base course mix on a subgrade or sand subbase;

c. Base course mixtures for shoulders and widening less than 10½ feet wide; or

d. Top and leveling course mixes for shoulders and widening less than 8 feet wide.

Place HMA mix in layers, and do not exceed the application rate. If the application rate for an HMA pavement exceeds the maximum rates specified in Table 501-4 and the edges are not confined, construct the pavement in at least two layers.

Table 501-4:
HMA Application Rates

Mix Number[(a)]	Course Application	Application Rate (lb/yd^2), minimum – maximum[(b)]
2	Base	435–550
3	Base, leveling	330–410
4	Leveling, top	220–275
5	Top	165–220

(a) See Table 501-1 for the mix number design parameters.
(b) Minimum application rates do not apply to wedging courses.

Wedge with HMA to remove irregularities in the existing road surface. Place and compact HMA wedging to correct the foundation. Allow the wedging to cool enough to support construction equipment without causing visible distortion of the mat before placing subsequent wedging, base, leveling, or top course mixtures.

Place HMA mix to the slope and width shown on the plans. Place subsequent HMA course to align the vertical edge with the previous courses, without constructing a ledge. Correct ledges that result from

placing material in excess of the width shown on the plans at no additional cost to the Department.

Place shoulder aggregate and compact flush after placement of each layer of HMA at the end of the paving day or place traffic control devices in accordance with subsection 812.03, at no additional cost to the Department. Complete final shaping and compaction of the shoulders after placing the top course of HMA.

If delays slow paving operations and the temperature of the mat immediately behind the screed falls below 200°F, stop paving and place a transverse construction joint. If the temperature of the mat falls below 190°F before initial breakdown rolling, remove and replace the mat at no additional cost to the Department.

If placing the uppermost leveling and top course, place the longitudinal joint to coincide with the planned painted lane lines.

If the temperature of the mat falls below 170°F before placing the adjacent mat, apply bond coat to the vertical edge of the mat.

If constructing the lanes with at least two pavers in echelon, match the depth of loose HMA from each paver at the longitudinal joints.

2. **Joints in HMA Pavement**

   a. **Transverse Construction Joint.** If constructing a transverse construction joint, stop the paver and lift the screed before material falls below the auger shaft. Remove the paver and roll through the planned joint location. Cut a transverse vertical joint and remove excess HMA.

      Place burlap, canvas, or paper as a bond breaker ahead of and against the vertical face. Place HMA against the bond breaker and taper from the new mat to the existing surface. Extend the temporary taper 5 feet for each inch of mat thickness, or as directed by the Engineer. Compact and cool the temporary taper before allowing traffic on the new surface. Remove the temporary taper before resuming paving.

   b. **Feather Joint**. Transition the new mat to existing surfaces at the beginning and end of resurfacing sections and at intersections unless using butt joints. Transition the new mat to existing surfaces at a rate of 1 inch over 35 feet. Construct transitions on a cured bond coat applied at a rate of 0.10 gallon per square yard. After compaction, spray with bond coat, sand, and roll the first 3 feet of the joint and 1 foot of the existing surface.

c. **Vertical Longitudinal Joint.** When opening to traffic, plan the work to resurface adjacent lanes to within one load of the same ending point at the completion of paving operations each day. Construct a vertical joint to conform to the pavement cross section.

When compacting an unsupported (unconfined) edge of the mat, keep the roller from 3 to 6 inches inside the unsupported edge on the first pass; ensure that the roller overhangs the unsupported edge by 3 to 6 inches on the second pass.

When placing HMA in a lane adjoining a previously placed lane, place the mixture so that the strike-off shoe will produce an edge that is adjacent to or minimally overlaps the adjoining course. Compact the longitudinal joint by rolling from the hot side, keeping the edge of the roller approximately 6 inches to 8 inches inside the cold joint for the first pass. For the second pass of the roller, compact the joint from the hot side while overlapping the cold side by 6 to 8 inches.

d. **Tapered Overlapping Longitudinal Joint.** A tapered overlapping longitudinal joint may be used instead of a longitudinal vertical joint.

If using tapered overlapping longitudinal joints, resurfacing lanes within one load of the same point-of-ending at the completion of paving operations each day is not required. Pave adjacent lanes within 24 hours unless delayed by inclement weather or approved by the Engineer.

Construct the tapered overlapping longitudinal joint by tapering the HMA mat at a slope no greater than 1:12. Extend the tapered portion beyond the normal lane width.

Place a ½-inch to 1-inch notch at the top of the taper on paving courses.

Provide a uniform slope by constructing the tapered portion of the mat using a Department-approved strike-off device that will not restrict the main screed.

Apply bond coat to the surface of the taper before placing the adjacent lane.

3. **Placing HMA Shoulders.** Use a self-propelled mechanical paver or spreader to place HMA shoulders.

If placing the top course on new shoulders, or placing leveling, or top course on existing HMA shoulders at least 8 feet wide, place the mix using a paver with an automatically controlled and activated screed

and strike-off assembly and corresponding grade referencing equipment. Use grade-referencing equipment as directed by the Engineer.

Stop shoulder paving at crossroad approaches, auxiliary lanes, commercial driveways, and ramps. Do not pave through these areas.

4. **Placing HMA Approaches.** Place HMA on driveway or crossroad approach foundations, as approved by the Engineer.

   Place approaches in layers no greater than the application rate. Do not stop mainline paving of lanes adjacent to the approach to pave the HMA approach.

5. **Safety Edge.** Construct the safety edge on the shoulders at locations shows on the plans. The finished shape of the safety edge will be in accordance with *MDOT Standard Plan R-110* series. Ensure that the safety edge is constructed monolithically with the shoulder and is of the same material type. Prior to placing HMA shoulder overlays, prepare the existing shoulder material to provide a smooth and uniform paving surface. Excavate, trench, and/or shape the existing shoulder material so that the safety edge may be placed as required on the plans. Ensure that the existing material does not impede the paving equipment and placement of HMA. For new or reconstructed shoulders, prepare base materials in accordance with the plans.

   Use an approved longitudinal safety edge system to create a sloped edge profile onto the roadway shoulder. Use an approved safety edge system that compacts the HMA and provides a finished sloped wedge in accordance with the contract. Do not use a single plate strike off. Use a system that is adjustable to accommodate varying pavement thicknesses.

   Prior to commencing any shoulder work, provide a test section to demonstrate the safety edge finished shape and compaction of the proposed safety edge system. The Engineer may waive the test section if satisfactory evidence is provided that the proposed system has been successfully used on other MDOT or MDOT local agency projects. Ensure that all safety edge systems have been approved by the Engineer.

G. **Rolling.** Compact each layer of HMA in accordance with the contract and free of roller marks.

   Keep the surface of the steel roller wheels moist during rolling.

   Use a pneumatic tire roller on HMA overlay projects in the intermediate rolling position to knead HMA over existing pavement.

H. **Smoothness Requirements.** After final rolling, the Engineer may test the surface longitudinally and transversely using a 10-foot straightedge at selected locations in accordance with Michigan Test Method (MTM) 722. Construct the surface and correct variations, at no additional cost to the Department, to the tolerances specified in this subsection.

1. **Base Course**. Construct lower layers of base courses to a tolerance of ¾ inch and final layers of base courses to a tolerance of ⅜ inch.

2. **Leveling and Top Course**. For multiple course construction, construct lower courses to a tolerance of ¼ inch and top courses to a tolerance of ⅛ inch.

3. **Single Course Overlays**. Construct single courses to a tolerance of ¼ inch.

4. **Longitudinal Joints**. Construct adjacent lanes to a tolerance of ¼ inch for base and leveling courses and a tolerance of ⅛ inch for top courses.

5. **Drainage Structures, Monument Boxes, and Water Shutoffs**. Construct to a tolerance of ¼ inch.

I. **Weather Limitations**

1. **HMA Weather Limitations**. Place HMA in accordance with the following restrictions:

a. Do not place HMA or apply bond coat when moisture on the existing surface prevents curing;

b. Do not place HMA unless the temperature of the surface being paved is at least 35°F and there is no frost on or in the grade or on the surface being paved, unless otherwise approved by the Engineer in writing;

c. Place only HMA courses that are greater than 200 pounds per square yard if the temperature of the surface being paved is greater than 35°F;

d. Place only HMA courses that are greater than 120 pounds per square yard if the temperature of the surface being paved is at least 40°F; and

e. Place any HMA course if the temperature of the surface being paved is at least 50°F.

J. **Protection of Structures.** Protect bridges, curbs, gutters, driveways, sidewalks, barriers, and other appurtenances to prevent surfaces from becoming discolored during application of bond coat or HMA to the road

surface. Remove material from appurtenances, as directed by the Engineer, at no additional cost to the Department.

K. **Aggregate Shoulders.** On resurfacing projects, scarify existing aggregate shoulder surfaces before placing new aggregate material.

Maintain the shoulder for vehicles to pass the construction equipment. If Contractor operations or traffic disturbs the area between the pavement and the right-of-way line, restore the area to a condition approved by the Engineer at no additional cost to the Department.

L. **Monument Boxes.** Place or adjust monument boxes in accordance with section 821.

M. **Quality Control Plan.** Prepare and implement a QC plan for HMA in accordance with MDOT's *HMA Production Manual*.

Make adjustments in process controls to prevent production of non-conforming material instead of accepting payment at a reduced price. The Department will not allow continual production of non-conforming material at a reduced price instead of making adjustments.

The Engineer will not perform sampling or testing for QC or assist in controlling the HMA production and placement operations.

N. **HMA Mix Acceptance.** The Engineer will inspect field-placed material, perform QA sampling and testing, and monitor Contractor adherence to the Contractor's *HMA QC Plan*.

1. **HMA Field-Placed Inspection.** The Engineer will perform a visual inspection of HMA to identify areas requiring corrective action. The Engineer will inspect the base and leveling courses within 18 hours and the top course within 36 hours of placement. If the Engineer determines that corrective action is required, do not pave overlying courses until after corrective action is completed and the Engineer determines that the pavement is in conformance with the contract.

   The Engineer will determine the need for corrective action based on the factors specified in Table 501-5. Corrective action may include remedial treatment, including crack or surface sealing, or replacement.

   Submit an action plan to the Engineer that addresses all factors that resulted in the need for corrective action. Complete all corrective action required to repair or replace unacceptable work at no additional cost to the Department.

   If the Engineer and the Contractor agree, the Department may make a contract adjustment of no greater than 100% of the bid price for corrective action.

Table 501-5:
HMA Criteria for Corrective Action

Criterion[a]	Length	Extent[b]	Severity	Corrective Action[c]
Segregation	—	>215 ft²/ 328-foot LL	Heavy[d]	Replace
Rutting	—	>32 feet	>¼ inch average depth over the length of occurrence	Replace
Flushing	—	>108 ft²/ 328-foot LL	High[e]	Replace
Edge of paved shoulder	>33 feet	Visible ledges	>3 inches	Trim
Crack[g]	Any	Any	All	Seal[f]

LL = lane length

(a) Criteria apply to all courses except flushing, which applies to the top course only.

(b) Extent is calculated by summing locations within the required length.

(c) The appropriate corrective action depends on the extent and severity of the criteria and on the intended service life of the pavement.

(d) Segregation severity will be determined in accordance with MTM 326. If segregation thresholds are met twice on a paving course, the use of an MTD for the remaining paving for that course may be required at no additional cost to the Department.

(e) Flushing severe enough to significantly affect surface friction (Friction Number <35).

(f) Other corrective action may be required as crack frequency increases.

(g) A reflective crack determined by the Engineer to be caused by an underlying condition does not require corrective action.

The Department will not grant extensions of time for repair work to meet the inspection acceptance requirements specified in subsection 501.03.N.1.

The Engineer will determine the area subject to corrective action, for removal and replacement of top courses, as the longitudinal extent of corrective action multiplied by the width of the paving course affected.

The Department will accept HMA subject to corrective action as follows:

a. HMA placed for corrective action involving full removal and replacement will be accepted in accordance with the contract.

b. The area requiring corrective action other than full removal and replacement will not be measured for incentive payment.

c. If more than 10% of the area of a sublot requires corrective action, the sublot will not be measured for incentive payment.

2. **HMA Testing Acceptance**. The Engineer will accept HMA based on visual inspection, small tonnage, or QA sampling and testing

acceptance criteria The Engineer will notify the Contractor before conducting QA sampling to allow the Contractor to witness the sampling, but not in a manner that will allow alteration of production in anticipation of sampling. The Engineer will conduct QA sampling in accordance with MTM 313 or MTM 324.

a. **Visual Inspection Acceptance Criteria**. The Engineer may accept quantities less than 500 tons, of any individual mixture, in accordance with MDOT's *Materials Quality Assurance Manual*.

b. **Temporary Pavement Acceptance Criteria.** The basis for measuring the mixture quality is QC testing and the QC processes specified in the applicable contract specifications for Superpave or Marshall mixes. Provide a copy of QC result to the Department within 24 hours upon request. The Department is not required to perform QA testing for the temporary HMA but reserves the right to perform verification testing. All materials and HMA mixture requirements apply. The initial production lots will be waived upon request. There are no pay factor or price adjustments based on mixture volumetrics for the temporary HMA.

   Perform all maintenance with the exception of snow and ice removal during the seasonal shutdown period. Maintain temporary pavement until the completion of the contract or the opening to traffic of the new pavement.

   Correct all deficiencies with the temporary pavement. The Engineer will make a negative adjustment for deficiencies requiring repairs or renewals, not corrected within the time frames stated in section 812 and for each occurrence that maintenance is required on the temporary HMA. Contract price adjustments will be made, according to Table 501-6, for each occurrence that repairs or renewals are required on the temporary roadway that are not attributable to normal wear and tear of traffic, weather, or an inadequate base condition not addressed in the contract.

O. **Asphalt Binder Acceptance.** The Department will accept asphalt binder in accordance with Department procedures.

Table 501-6:
Contract Adjustments for Maintenance of Temporary Pavement

ADT[a]	Per Maintenance Occurrence
0–10,000	$2,000[b]
10,000–40,000	$4,000[b]
≥40,000	$8,000[b]

(a) Based on average daily traffic (ADT) shown on Title Sheet

(b) The contract adjustment will be doubled if the Contractor 's *HMA-QC Plan* is not adhered to.

501.04. Measurement and Payment

Pay Item	Pay Unit
HMA, 5 E __	Ton
HMA, 4 E __	Ton
HMA, 3 E __	Ton
HMA, 2 E __	Ton
HMA, (type), High Stress	Ton
HMA Approach	Ton
HMA Approach, High Stress	Ton
HMA, Temp Pavt (mix type)	Ton
Pavt for Butt Joints, Rem	Square Yard
Edge Trimming	Foot
Cold Milling HMA Surface	Square Yard, Ton
HMA Surface, Rem	Square Yard
HMA Patch, Rem	Square Yard
Joint and Crack, Cleanout	Foot
Hand Patching	Ton
Pavt, Cleaning	Lump Sum
Pavt Joint and Crack Repr, Det __	Foot

A. **HMA, (type), High Stress**. The Department may pay for HMA, (type), High Stress for up to 150 feet outside the limits shown on the plans to allow time to transition to the high-stress HMA. The Department will pay for high-stress HMA placed outside the 150-foot limit as other HMA mix pay items.

B. **Pavement for Butt Joints, Removal.** The unit price for **Pavt for Butt Joints, Rem** includes the cost of removing and disposing of concrete or HMA materials.

C. **Edge Trimming.** The Engineer will measure **Edge Trimming** along the cut edge. The unit price for **Edge Trimming** includes the cost of cutting, removing, and disposing of excess HMA material.

D. **Cold Milling HMA Surface.** The unit price for **Cold Milling HMA Surface** includes the cost of removing, loading, hauling, weighing, and disposing of the cold-milled material, and cleaning the cold-milled pavement. If paid by the ton for cold-milled HMA, deposit the cold-milled material directly from the cold milling machine into the hauling units and weigh on a scale meeting the requirements of subsection 109.01.B before placement in a stockpile or a disposal area.

Material picked up by cleaning after cold milling is not weighed or paid for.

Macrotexture testing, macrotexture corrective actions, cleaning, and all other work related to mean texture depth requirements will not be measured and paid for separately but must be included in the work.

Separate payment will not be made for providing and maintaining an effective *Cold-Milling QC Plan*, nor for providing and maintaining an effective *Cold-Milling Operations Plan*.

E. **Pavement, Cleaning.** The Engineer will measure **Pavt, Cleaning** as a unit, including paved shoulders, approaches, and widened areas. The unit price for **Pavt, Cleaning** includes the cost of cleaning the foundation, joints, and cracks, and sweeping shoulders, base courses, and leveling courses.

If the Engineer directs additional hand or mechanical methods to clean the pavement, the Department will pay for this work as **Joint and Crack, Cleanout** if the contract documents include the pay item. If the contract documents do not include a pay item for joint and crack cleanout, the Department will pay for additional hand or mechanical work as extra work, in accordance with subsection 109.05.

F. **Joint and Crack, Cleanout.** The Engineer will measure **Joint and Crack, Cleanout** along the cleaned joint and crack.

G. **Hand Patching.** The unit price for **Hand Patching** includes the cost of placing HMA, by hand or other methods, and compacting the material.

H. **Removing HMA Surface.** The Engineer will measure, and the Department will pay for removing HMA surface, no greater than 12 inches thick, overlying a material designated for removal or that is required to remain in place, as **HMA Surface, Rem**. The unit price for **HMA Surface, Rem** includes the cost of edge cutting to establish a neat line, as required, and removal and disposal of the HMA material.

For removal of HMA surfaces from structures, the unit price for **HMA Surface, Rem** includes the cost of removing old membrane.

The Engineer will measure, and the Department will pay for removing HMA surface, greater than 12 inches thick, overlying a material designated for removal or that is required to remain in place, as **Pavt, Rem** in accordance with subsection 204.04.

I. **Pavement Joint and Crack Repair.** The Engineer will measure **Pavt Joint and Crack Repr**, of the detail required, along the joint and crack. If the pavement joint and crack repair exceeds 30 inches in width, the Engineer will measure each 30-inch wide segment, or portion thereof, separately for payment. The Department will pay for the HMA material used to fill the joints after removal of objectionable material, as **Hand Patching**.

J. **Safety Edge.** Separate payment will not be made for constructing a safety edge. All costs associated with providing a safety edge, including base preparation and additional equipment or modification to existing equipment, will be included in the applicable unit prices for the related HMA mixtures.

K. **HMA.** The Engineer will measure, and the Department will pay for, **HMA** and **HMA, Temp Pavt (mix type)** of the mix specified based on the weight placed, as supported by weigh tickets. The Engineer will adjust the unit price for HMA of the mix specified, in accordance with the contract.

Section 502. HMA Crack Treatment

502.01. Description

This work consists of treating cracks in HMA surfaces using both a saw or rout and seal process and an overband process.

A. **Definitions**

Primary Crack. Crack ⅛ inch to 1¼ inch wide with less than 25% of its length having secondary cracking.

Secondary Crack. Series of parallel cracks with no or few interconnecting cracks to the primary crack.

502.02. Materials

Provide materials in accordance with the following section:

Joint and Crack Sealants for Construction.....914

A. **Saw or Rout and Seal.** Provide a hot-poured, extra low-modulus, joint-and-crack sealant product from the Qualified Products List. Follow manufacturer's recommendation for material installation.

B. **Overband.** Provide an overband crack fill asphalt rubber product from the Qualified Products List. Follow manufacturer's recommendation for material installation.

502.03. Construction

A. **Equipment.** Provide equipment capable of meeting the requirements of this subsection.

1. **Compressed Air System**. Provide and use a compressed air system that produces a continuous, high-volume, high-pressure stream of clean, dry air to prepare cracks. Equip the air compressor with a moisture separator to remove oil and water from the air supply. Provide a compressor capable of producing at least 100 psi at a continuous air flow of 150 cfm.

2. **Melter Applicator**. Provide a melter applicator consisting of a boiler kettle equipped with pressure pump, hose, and applicator wand. Equip the unit with the following:

   a. Shutoff control on the applicator hose;

   b. Mechanical agitator in the kettle to provide continuous blending;

   c. Thermometers to monitor the material temperature and the heating oil temperature; and

d. Thermostatic controls that allow the operator to regulate material temperature up to 425°F.

3. **Application Wand**. Apply the material using either a wand followed by a V-shaped or U-shaped squeegee or a round application head with a concave underside.

B. **Pre-Production Meeting.** Before beginning work, conduct an on-site pre-production meeting with the Engineer to discuss the following:

1. Contractor's detailed work schedule;
2. Traffic control plan;
3. Required project documentation;
4. Review crack treatment methods criteria;
5. Inspection of the condition of equipment;
6. The Contractor's *QC Plan*; and
7. The Contractor's designated Authorized Representative.

C. **Crack Preparation.** Clean and dry cracks using compressed air and other tools to remove loose dirt, vegetation, and deleterious material. Clean cracks no more than 10 minutes before filling. Any debris or vegetation removed from cracks in a curb and gutter section will be removed and disposed at no additional cost to the Department.

D. **Crack Treatment Methods**

1. **Saw or Rout and Seal.** Treat primary transverse cracks in the pavement surface using the saw or rout and seal process. Treat primary transverse cracks in the shoulders unless otherwise directed.

   Saw or rout, clean, and fill all primary transverse cracks. The Department defines a transverse crack as a crack less than 10 degrees off of perpendicular to the centerline.

   The following cracks should not be sealed:

   a. Secondary cracks;
   b. Multiple nearby cracks that have raveled; and
   c. Multiple cracks that include broken asphalt.

   Saw or rout all primary transverse cracks as defined above by creating a reservoir along the crack. Create the reservoir to a volume of at least 7.5 cubic inches per foot of crack and with a 1:1 width-to-depth ratio. Ensure that the finished reservoir walls are vertical and the reservoir bottom is flat. Fill the reservoir such that the final level is

flush with the pavement surface and spread uniformly over the entire length of the crack. The width of the overband, including the routed reservoir, must be no more than 2½ inches wide with a thickness of ⅛ inch.

2. **Overband.** The Contractor will treat all other primary and secondary cracks with material placed in an overband configuration.

   Apply overband material to clean, dry cracks. Apply overband 4 inches wide, ±½ inch and from ⅛ inch to $^{3}/_{16}$ inch thick.

   The Contractor may increase the maximum application width to 6 inches for coverage of multiple cracks, with Engineer approval.

   Place temporary pavement markings before opening the road to traffic if overband material obliterates existing pavement markings.

   Apply overband as follows unless otherwise required:

   a. **Stand Alone Overband Crack Fill**. If no other surface treatment is required on the pavement, fill visible cracks in the road less than 1¼ inch wide.

   b. **Micro-Surfacing Preparation**. If preparing the pavement for a micro-surface overlay, fill visible cracks in the road less than 1¼ inch wide. Allow to cure for a minimum of 3 days prior to placement of micro-surface.

   c. **Chip Seal Preparation**. If preparing the pavement surface for a single or double chip seal, fill cracks with widths from ¼ inch to 1¼ inch or 3 feet or longer. Allow to cure for a minimum of 7 days prior to placement of chip seal.

   d. **Paver-Placed Surface Seal (PPSS)**. If preparing the pavement for a paver-placed surface seal, fill cracks with widths from ¼ inch to 1¼ inch or 3 feet or longer. Allow to cure for a minimum of 14 days prior to placement of PPSS.

   e. **HMA Ultra-Thin Overlay**. If preparing the pavement for an HMA ultra-thin overlay, fill visible cracks less than 1¼ inch wide. Allow to cure for a minimum of 14 days prior to placement of the HMA ultra-thin overlay.

      Do not seal the following cracks when preparing the pavement for micro-surfacing, chip seals, paver-placed surface seals, or HMA ultra-thin overlays:

      i. Multiple nearby cracks that have raveled;

      ii. Multiple cracks that include broken asphalt; and

iii. Multiple longitudinal cracks in each wheel path.

E. **Weather Limitations.** Place material at air temperatures from 45°F to 85°F. Do not place material if moisture is present in the crack.

F. **Cure Time and Repair.** Allow the material to cool before opening the road to traffic. Apply detackifying solution, if required, to protect the uncured crack treatment material from tracking. Do not use blotting materials, including sand, aggregate, sawdust, or paper. Repair treated pavement areas, damaged by traffic at no additional cost to the Department.

G. **Quality Control.** Provide and follow a QC plan for production and construction processes. Provide the Engineer with a copy of the QC plan for review and approval, prior to the pre-production meeting. Maintain QC measures until the Engineer accepts the work.

Comply with the approved QC plan throughout the project and allow the Engineer access to work in progress for assurance review and testing. If the Engineer identifies a condition causing unsatisfactory crack treatment, immediately stop production and correct the work at no additional cost to the Department.

Ensure that the QC plan addresses the following:

1. A detailed description explaining how field crews will determine primary transverse and all other primary and secondary cracks. Separately detail projects with multiple pavement sections;
2. The sealant material and equipment used to heat, handle, and apply sealant material in accordance with the manufacturer’s specifications. Provide the material manufacturer’s specifications to the Engineer upon request;
3. Saw or rout and seal operation reservoir configuration;
4. Procedures for crack cleaning;
5. Replacement criteria for cutting tools;
6. Controls implemented to ensure that flying dust and debris are not directed toward adjacent traveled lanes, pedestrians, parked vehicles, or buildings;
7. An action plan for adjusting crack sealing operations to address actual environmental conditions if adverse environmental conditions occur; and
8. Proposed procedure for monitoring the work to ensure that acceptance requirements are met.

H. **Acceptance.** Upon completion of work, schedule an inspection with the Engineer. The Engineer will note deficiencies, including areas exhibiting adhesion failure, cohesion failure, missed cracks, or other factors the Engineer determines unacceptable. Correct the unacceptable work. Notify the Engineer upon completion of corrective work.

502.04. Measurement and Payment

Pay Item	Pay Unit
Overband Crack Fill, Lane	Lane Mile
Overband Crack Fill, Ramp	Lane Mile
HMA Crack Treatment, Lane	Lane Mile
HMA Crack Treatment, Ramp	Lane Mile

A. **Overband Crack Fill.** The Engineer will measure **Overband Crack Fill, Lane** along the centerline of each lane. This measurement includes traffic lanes, as defined in the Lane Mile Inventory, and any adjacent paved shoulders.

The Engineer will measure **Overband Crack Fill, Ramp** along the ramp centerline beginning at the 2-foot gore point including shoulders.

The unit prices for **Overband Crack Fill**, of the type required, include the cost of preparing and filling cracks using the overband method, providing the required documentation, corrective work, and temporary traffic markings.

B. **HMA Crack Treatment.** The Engineer will measure **HMA Crack Treatment, Lane** along the centerline of each lane. This measurement includes traffic lanes, as defined in the Lane Mile Inventory, and adjacent paved shoulders.

The Engineer will measure **HMA Crack Treatment, Ramp** along the ramp centerline beginning at the 2-foot gore point including shoulders.

The unit price for **HMA Crack Treatment,** of the type required, includes the cost of preparing, filling, and sealing the cracks, including treating primary transverse cracks with the saw or rout and seal method, and treating all other primary and secondary cracks with the overband method.

Section 503. Paver-Placed Surface Seal

503.01. Description

This work consists of the surface preparation and application of a paver-placed surface seal (PPSS).

503.02. Materials

Provide materials in accordance with the following sections:

A. **Asphalt Binder Selection Criteria.** Provide PG asphalt binder in accordance with Table 503-1.

Table 503-1:
Performance-Graded (PG) Asphalt Binder Selection Criteria

Location	PG Asphalt Binder
North of M-72 in the Lower Peninsula and Upper Peninsula	PG 64-28P
South of M-72 (including M-72)	PG 70-28P
MDOT Metro Region only	PG 70-22P

B. **PPSS Mixture Design.** The mixture must be designed by a Department-approved laboratory. Design the mixture in accordance with Table 503-2 so the asphalt binder produces a film thickness of at least 10 microns. Calculate the film thickness in accordance with the National Center for Asphalt Technology's *Hot Mix Asphalt Materials, Mixture Design and Construction*. Submit the mix design to the Engineer at least 7 days before beginning construction.

Do not use reclaimed material in the mixture.

C. **Mixture Design Documentation.** Provide the following documentation with the mixture design:

1. Contractor Bituminous Mix Design Communication (Form 1855);
2. Sample Identification, include with AWI sample (Form 1923);
3. Average maximum percent draindown for each test temperature (report);
4. Tensile Strength Worksheet (Form 1937);
5. Calculation of film thickness (report);

6. The material sources for the mixture design; and
7. Test results verifying the mixture meets the requirements in Table 503-2 and the specified film thickness.

Table 503-2:
Mixture Requirements

Mix Type	Aggregate	% Asphalt Binder Content	Draindown Test (% Max) AASHTO T305[(a)]	Moisture Sensitivity (% Min) AASHTO T283[(b)]
B	30SS	4.8–6.2	0.10	80
C	27SS	4.6–6.2	0.10	80

(a) Conduct the draindown test at the JMF asphalt content plus 0.5%. Test the draindown at the mixing temperature plus 27°F but do not exceed 350°F.

(b) Compact specimens for AASHTO T283 testing using the SGC at 100 gyrations with target dimensions of 6 inch diameter × 3¾ inch ±⅛ inch height or 4 inch diameter × 2½ inch ± ⅛ inch height. Do not adjust the number of revolutions to target an air void range. Cure the loose bituminous surface course mixture 1 hour at the specified application temperature. The minimum time for vacuum saturation is 20 minutes. Subject specimens to freeze-thaw conditioning. If an anti-stripping agent is needed, report the amount and type with the mixture design.

503.03. Construction

A. Equipment

1. **Self-Priming Machine**. Provide a self-priming machine that sprays polymer modified emulsion membrane and places a PPSS over the membrane in a single pass, continuous application. The self-priming machine must not contact the polymer-modified emulsion membrane before applying the PPSS. The self-priming machine must include the following:

   a. A receiving hopper with at least two heated, twin screw, and mix-feed augers;

   b. An integral storage tank for the polymer-modified asphalt emulsion;

   c. Twin expandable emulsion spray bars, immediately in front of the PPSS feed augers and ironing screed. The spray bars must be able to measure the application of polymer-modified asphalt emulsion and monitor the rate of spray across the width of the paving pass; and

   d. A variable-width vibratory heated ironing screed that is adjustable and capable of providing positive and negative crowns to the thickness and cross section shown on the plans.

2. **Compacting Equipment**. Use at least two 10-ton steel-wheeled rollers meeting the requirements in subsection 501.03.A.5.

B. **Pre-Production Meeting.** Before beginning work, conduct an on-site pre-production meeting with the Engineer to discuss the following:

1. Work schedule;
2. Traffic control plan;
3. Equipment calibrations and adjustments;
4. Condition of equipment;
5. QC plan; and
6. Contractor's authorized representative.

C. **Weather and Seasonal Limitations**

1. **Weather Limitations**. Place PPSS on dry pavement. Do not place PPSS if the air temperature is below 50°F.
2. **Seasonal Limitations**. Place PPSS from May 1 to October 15.

D. **PPSS Placement**

1. **Surface Preparation.** Perform all surface preparation prior to applying the wearing course.

   Clean the existing surface of loose materials, vegetation, dirt, dust, mud, and other deleterious materials. Remove animal remains before placing the mixture.

   Protect drainage structures, monument boxes, water shut-offs, and other existing structures using tarpaper or other protective coverings approved by the Engineer. Remove the protective coverings before opening to traffic.

   Remove pavement markings.

2. **Emulsion Membrane**. Apply a polymer-modified asphalt emulsion membrane at a rate of 0.20 gallons per square yard. Field adjustments of the emulsion application rate for changes in existing pavement surface conditions or limitations of the HMA mix design will be allowed. Apply the polymer-modified asphalt emulsion membrane at a temperature from 140 to 175°F.
3. **PPSS**. Apply Type B surface course mixtures at a rate of 83 pounds per square yard and Type C surface course mixtures at a rate of 90 pounds per square yard. Use an application rate that provides a PPSS thickness that prevents the fracture of aggregate by the screed. Apply the PPSS mix at a temperature from 300 to 330°F and compact before the placed surface course cools to 185°F.

4. **Rough Joints**. At no additional cost to the Department, repair transverse and longitudinal construction joints resulting from PPSS operations that cause bumps or poor riding joints, as determined by the Engineer. The repairs must meet the approval of the Engineer.

E. **Quality Control.** Prepare and implement a QC plan, in accordance with requirements of section 501, that will detail QC operations for production and construction. Submit the QC plan to the Engineer for review and approval before the pre-production meeting.

Notify the Engineer immediately and stop mixture production if the QC test results exceed any tolerance shown in Table 503-3. Identify the cause of the deviation and determine the corrective action necessary to bring the mixture into compliance prior to resuming mixture placement.

Perform, at a minimum, the following QC tests.

1. **PPSS Surface Course.** Perform three yield checks each day to determine the application rate of the HMA surface course. The yield must be within 5 pounds per square yard of the target application rate.

2. **PPSS Mixture.** Take a sample of the PPSS mixture from the truck transports in accordance with ASTM D979/D979M and reduce the sample size in accordance with MTM 313. Test this sample before beginning production the following day. Test results must fall within the quality control tolerances specified in Table 503-3.

Table 503-3:
PPSS Quality Control Tolerances

Sieve Size	Mix Type B Tolerance[(a)]	Mix Type C Tolerance[(a)]
¾ inch	—	—
½ inch	—	±5%
⅜ inch	±5%	±5%
No. 4	±5%	±5%
No. 8	±4%	±4%
No. 200	±1%	±1%
PG asphalt binder content	±0.4%	
Film thickness	10 microns (min)	

(a) Tolerance in reference to values listed in Table 902-7.

F. **Acceptance.** Review completed portions of the PPSS placement with the Engineer for compliance with the contract. If the Engineer determines the PPSS does not comply with the contract, repair defects at no additional cost to the Department.

503.04. Measurement and Payment

Pay Item	Pay Unit
Paver-Placed Surface Seal, Type __	Square Yard

The unit price for **Paver-Placed Surface Seal**, of the type required, includes the cost of preparing the surface, placing temporary pavement markings, and placing a membrane and paver placed surface seal course for full-width coverage, except that the Department will pay separately for removing pavement markings in accordance with subsection 812.04.

Section 504. Micro-Surfacing

504.01. Description

This work consists of the surface preparation and application of a single course micro-surfacing or multiple course micro-surfacing.

504.02. Materials

Provide materials in accordance with the following sections:

Portland Cement, Type I 901
Fine Aggregates, 2FA, 3FA 902
Asphalt Emulsion, CSS-1hM, CSS-1mM 904
Water 911

A. **Aggregate.** Provide aggregates complying with gradation and physical requirements in Tables 902-7 and 902-8.

Use 3FA fine aggregate in micro-surfacing mixture for rut filling.

Use 3FA or 2FA fine aggregates in micro-surfacing mixtures for micro-surfacing and longitudinal micro-surfacing.

Use 2FA fine aggregate in micro-surfacing mixture for single-course applications.

Aggregate used for micro-surfacing must be screened at the project site to ensure that aggregate being introduced into the micro-surface mixture is not larger than the top size aggregate allowed in the mix design. The aggregate must be screened directly into the material transport units or micro-surface machine(s). The aggregate screening unit must be capable of producing adequate tonnage to maintain project production.

B. **Mix Design.** Provide micro-surfacing mixtures consisting of a blend of polymerized asphalt emulsion, fine aggregate, portland cement, water, and other additives.

The mixture must be designed by a laboratory that participates in AASHTO re:source's Proficiency Sample Program. Submit the mix design to the Engineer at least 7 days before beginning construction.

Provide a JMF meeting the criteria shown in Table 504-1 and limits shown in Table 504-2 to the Engineer at the pre-production meeting.

Submit a new mix design for changes in aggregate or asphalt emulsion sources.

Table 504-1:
Micro-Surfacing Performance Design Criteria

Test Method	Parameter	Specification
ISSA TB-114	Wet stripping	≥90%
ISSA TB-100	Wet track abrasion loss	—
	1-hour soak	≤50 g/ft²
	6-day soak	≤75 g/ft²
ISSA TB-144	Saturated abrasion compatibility	≤3 g loss
ISSA TB-113	Mix time at 77°F	Controllable to ≥120 s
	Mix time at 100°F	Controllable to ≥35 s

Table 504-2:
JMF Limits

Test Method	Specification
Asphalt binder content (residual)	7.5%–9.0%, dry weight, 2FA aggregate
	7.0%–8.5%, dry weight, 3FA aggregate
Mineral filler	0.25%–3.0%, dry weight aggregate

C. **Mix Design Documentation.** Provide the following information in the final mix design:

1. Proportion of each material;
2. Sources of each material, including:
    a. Aggregate;
    b. Name and pit number;
    c. Gradation;
    d. Sand equivalence; and
    e. Angularity index;
3. Field simulation tests, including:
    a. Wet stripping tests;
    b. Wet track abrasion loss;
    c. Saturated abrasion compatibility; and
    d. Trial mix time at 77°F and 100°F;
4. Interpretation of results and the determination of a JMF, including:
    a. Mineral filler, percent (minimum and maximum);

b. Water, including aggregate moisture, percent (minimum and maximum);

c. Mix set additive, percent;

d. Modified emulsion in mix, percent;

e. Residual asphalt content of modified emulsion, percent; and

f. Residual asphalt content in mix, percent;

5. Average daily traffic (ADT) for the pavement sections where placing mix; and

6. Mix designer's signature and date.

D. **Bond Coat.** Use the same emulsion for bond coat as used in production of the mixture.

504.03. Construction

A. **Equipment.** Provide equipment that can produce a specification product.

1. **Mixing Machine**. Provide at least one self-propelled, front-feed, continuous-loading mixing machine equipped and operated as follows:

a. A positive-connection conveyer belt aggregate delivery system and an interconnected positive displacement, water-jacketed gear pump to proportion aggregate and asphalt emulsion;

b. Continuous-flow, twin-shaft, multi-blade type pugmill at least 50 inches long;

c. Mineral filler feed that drops mineral filler on the aggregate before discharging into the pugmill;

d. Asphalt emulsion introduced within the first one-third of the mixer length to ensure mixing of materials before exiting the pugmill;

e. Rate indicators for proportioning each material, readily accessible and positioned to allow determination of the quantity of each material. Calibrate and test each material rate indicator to ensure proper operation before production;

f. A water pressure system and nozzle type spray bar to provide water spray in front of and outside the spreader box. Apply water to dampen the existing pavement surface without causing free-flowing water in front of the spreader box;

g. Opposite-side driving stations on the front to optimize longitudinal alignment during placement; and

h. Remote forward-speed control at the rear-mixing platform for the back operator to control forward speed and level of mixture in the spreader box.

Provide enough transports to ensure continuous operation during mix production and application. Use transport units with belt-type aggregate delivery systems, emulsion storage tanks, and water storage tanks to proportionally mix aggregate delivered by each transport.

The Contractor may use truck-mounted batch-type machines on projects or sections of projects smaller than 15,000 square yards. Provide at least two truck-mounted batch-type machines. Stop mix production if delays exceed 15 minutes.

Calibrate mixing machines before use. Maintain documentation of the calibrations of each material-metering device at various settings. Supply materials and equipment, including scales and containers, for calibration. Recalibrate mixing machines after changes in aggregate or asphalt emulsion sources.

2. **Spreader Box**. Provide a mechanical-type spreader box, attached to the mixer and equipped with paddles mounted on adjustable shafts, to continually agitate and distribute the mixture. Equip spreader boxes with the following:

   a. Front and rear flexible seals capable of maintaining direct contact with the road;

   b. A secondary strike-off, attached to the spreader box, capable of providing a finished smooth surface texture on the final or surface pass; and

   c. A drag capable of producing a uniform finish. Replace the drag if mixture builds up.

3. **Rut Box**. Use an Engineer-approved steel V-configuration screed rut box designed and manufactured to fill ruts to perform micro-surface rut filling applications. Ensure a mixture spread width from 5 to 6 feet and use a secondary strike-off to control crown on the rut box. A third strike-off may be used to control texture.

4. **Longitudinal Box**. Provide a steel screed box designed and manufactured to distribute the mixture to perform micro-surface longitudinal application. The device must be capable of spreading mixture 2 to 4 feet wide and use a secondary strike-off to control crown on the box.

5. **Miscellaneous Equipment**. Provide hand squeegees, shovels, and other equipment to perform the work. Provide cleaning equipment for surface preparation, including power brooms, air compressors, water-flushing equipment, and hand brooms.

6. **Lights on Equipment**. Equip power brooms, distributors, and truck mount spreaders with at least one Department-approved, flashing, rotating, or oscillating amber light, visible in every direction. Equip continuous spreader units with one light on each side of the spreader.

B. **Pre-Production Meeting.** Before beginning work, conduct an on-site pre-production meeting with the Engineer to discuss the following:

1. Detailed work schedule;
2. Traffic control plan;
3. Plan for filling corrugations;
4. Equipment calibration;
5. Equipment calibration calculations;
6. Equipment inspection, including transport units;
7. Test strips to check the material and demonstrate placement procedures;
8. JMF; and
9. Availability of materials.

If using multiple machines, lay a test strip with each machine at the time of the pre-production meeting. Immediately upon completion of the test section the Engineer will evaluate the test area to determine if the application rates are acceptable. Full production work may only begin after the Engineer accepts the test section.

C. **Surface Preparation.** Immediately before surfacing operations, remove pavement markings using an abrasion method.

Clean existing surface of loose materials, vegetation, dirt, dust, mud, and other deleterious materials. Remove animal remains before placing the mixture.

Protect drainage structures, monument boxes, water shut-offs, and other existing structures during bond coat and mix application.

Apply bond coat on concrete surfaces. Mix bond coat with one part emulsion to two parts water. Apply the bond coat at a rate from 0.035 gallon per square yard to 0.070 gallon per square yard, without excessive runoff. Allow the bond coat to cure before placing mixture.

Before placing the mixture, establish, identify, and maintain 1,000-foot intervals until project completion.

D. **Application Methods and Rates.** Apply micro-surface mixtures to fill minor cracks and ruts in the roadbed, to construct a uniform surface with straight longitudinal joints, transverse joints, and edges.

1. **Rutfilling.** Fill ruts if the rut is at least ½-inch deep and the contract includes the pay items for either standard micro-surfacing or rut filling. Use a 3FA mixture for rut filling and apply using a rut box for each wheel track.

   Maintain a clean overlap and straight edges between wheel tracks. Limit each pass of rut filling to no deeper than 1 inch. For each 1 inch of mix, provide an additional ⅛-inch crown.

2. **Micro-Surface Longitudinal**. Fill centerline corrugations or longitudinal joints. When filling corrugations, fill the corrugations to allow new corrugations to be established. Apply at least one course of 2FA mix at the needed application rate.

3. **Micro-Surfacing**. Select one of the following application methods for micro-surfacing:

   a. Apply at least one course of 3FA mix to the pavement surface, as indicated in the plans, at an average application rate of at least 35 pounds per square yard, by weight of dry aggregate. Apply 3FA mix to pavement surface, as indicated in the plans, at a rate of at least 22 pounds per square yard, by weight of dry aggregate.

   b. Apply at least two courses of 2FA mix to the pavement surface, as indicated in the plans, at an average combined application rate of at least 30 pounds per square yard, by weight of dry aggregate. Apply 2FA mix to pavement surface, as indicated in the plans, at a rate of at least 17 pounds per square yard, by weight of dry aggregate.

   c. If using to fill shoulder corrugations, fill the corrugation area with a separate pass of micro-surfacing material prior to application of the top course. When a chip seal is applied to the shoulder as part of the project, a separate pass of micro-surfacing will not be required prior to application of the top course. Fill the corrugations to allow new corrugations to be established. Only a single course of micro-surfacing is required to fill shoulder corrugations.

4. **Single Course Micro-Surfacing**. Apply a single course using 2FA mix at an average minimum application rate of 24 pounds per square yard,

by weight of dry aggregate, to the pavement surface, as indicated in the plans.

E. **Surface Quality**

1. **Joint Construction.** Place longitudinal construction joints and lane edges to coincide with the planned painted lane lines. Construct longitudinal joints with less than 3 inches overlap on adjacent passes and no more than ⅜-inch-thick overlap as measured with a 10-foot straightedge. To prevent water from collecting on the pavement surface, place successive passes on the upslope side of the overlap.

   Construct neat and uniform transverse joints with less than a ⅛-inch difference in elevation across the joint as measured with a 10-foot straightedge. Provide neat and uniform lane edges with no greater than 2 inches of horizontal variance over 100 feet. Immediately stop work to correct defective joints or edges and obtain the Engineer's approval before resuming work.

2. **Cross Section**. Restore the driving lane cross section to within ¼ inch of the planned elevation, measured transversely across the pavement with a 10-foot straight edge or areas of the segment within 6 inches of the edge line, lane line, or centerline.

F. **Cure Time and Repair.** Do not allow traffic on the mixture until it cures. Ensure the new surface can carry normal traffic without damage within 1 hour of application. Protect the new surface from damage at intersections and driveways. Repair damage to the mixture caused by traffic at no additional cost to the Department.

G. **Weather and Seasonal Limitations**

1. **Weather Limitations.** Place the mixture when the air and pavement temperatures reach at least 45°F.

   Do not place mixture in rain, inclement weather, or when the air temperature is forecast to be below 32°F within 24 hours of work completion.

2. **Seasonal Limitations**. Place mixture from June 1 to September 15 in the Upper Peninsula and from May 1 to October 15 in the Lower Peninsula.

H. **Quality Control.** Provide a finished surface free of excessive scratch marks, tears, rippling, and other surface irregularities, as determined by the Engineer. Do not leave ripples greater than ⅛ inch as measured by a 10-foot straight edge in accordance with MTM 722. Do not leave tear marks greater than ½ inch wide and 4 inches long, or other marks greater than 1 inch wide and 1 inch long. If the finished surface exceeds the

specified tolerances, stop work immediately and correct irregularities. Review corrective action with the Engineer before resuming production.

Produce a mixture that will meet the JMF and the QC tolerances specified in Tables 504-3 and 504-4. Notify the Engineer immediately if QC test results exceed the tolerances specified in Tables 504-3 and 504-4 and stop mix production. Identify the cause of the deviation and determine the corrective action necessary to bring the mixture into compliance. Obtain the Engineer's approval before resuming work.

The Engineer reserves the right to verify QC test accuracy and production controls.

If the Engineer identifies a condition that causes an unsatisfactory micro-surfacing treatment, immediately stop production work and correct the defect at no additional cost to the Department.

Table 504-3:
Micro-Surfacing Quality Control
Aggregate Gradation Tolerances

Sieve Size	Tolerance
No. 4	±5.0%
No. 8	±5.0%
No. 16	±5.0%
No. 30	±5.0%
No. 50	±4.0%
No. 100	±3.0%
No. 200	±2.0%

Table 504-4:
Micro-Surfacing General Quality Control Tolerances

Parameter	Tolerance
Asphalt cement content single test	±0.5% from JMF
Asphalt cement content daily average	±0.2% from JMF
Application rate (as determined by 1000-foot yield checks)	±2 pounds per square yard
Sand equivalent test (ASTM D2419)	±7% from JMF

1. **QC Plan Contents**. Provide and follow a QC plan, in accordance with requirements of section 501, that will maintain QC for production and construction processes. Provide the Engineer with a copy of the QC plan for review and approval before the pre-production meeting.

   Include, at a minimum, the following items:

   a. The source of materials used on the project;

b. The sampling and testing methods used to determine compliance with material specifications;

c. A detailed description of how field crews will determine pavement rut depths and locations; detail each section of multiple pavement sections separately;

d. The equipment to be used on the project;

e. The calibration method used to determine compliance with the mix design (JMF);

f. The pavement cleaning and preparation procedure;

g. A plan for protecting micro-surfacing mixture from damage by traffic;

h. A procedure for monitoring initial acceptance requirements; and

i. An action plan demonstrating adjustments of the micro-surfacing operation for adverse environmental conditions.

2. **Minimum QC Sampling and Testing Frequency**. Include the following minimum QC sampling and testing frequencies in the QC Plan:

   a. **Fine Aggregate Gradation**. Sample fine aggregate from the project stockpile and test for gradation. Perform one test per 500 tons of fine aggregate or one test per day of mixture production, whichever is less.

   b. **Sand Equivalent Test (ASTM D2419)**. Perform at least one sand equivalency test for each mixture design.

   c. **Asphalt Content**. Calculate the percent asphalt content of the mixture at least three times per day, on a random basis, using the equipment counter readings.

   d. **Application Rate**. Calculate the yield of the course placed at least three times per day, on a random basis, using the equipment counter readings.

3. **Documentation**. Complete a daily report that includes the following information:

   a. Control section;

   b. Job number;

   c. Route;

   d. Engineer;

e. Date;

f. Air temperature;

g. Control settings;

h. Calibration values;

i. Unit weight of emulsion (pounds per gallon);

j. Percent residue in emulsion;

k. Beginning and ending intervals;

l. Counter readings (beginning, ending, and total difference);

m. Length and width;

n. Total area (square yards);

o. Aggregate weight;

p. Gallons of emulsion;

q. Percent of each material including asphalt cement;

r. Application rate (pounds per square yard);

s. Combined application rate (pounds per square yard);

t. JMF (percent portland cement, percent emulsion, gradations, percent asphalt cement);

u. Contractor's authorized signature;

v. Calibration forms;

w. QC aggregate gradations;

x. Materials acceptance documentation;

y. Asphalt emulsion bill of lading; and

z. QC and equivalent test result(s).

If truck-mounted machines are used, complete a separate daily report for each machine.

4. **Field Tests**. Before opening micro-surfacing to traffic, perform both of the following field tests:

   a. Probe the entire depth of the micro-surfacing to verify no free emulsion exists in the mixture; and

b. Place a white absorbent paper blotter on the micro-surfacing to confirm the presence of clear water without brown staining from unbroken emulsion.

I. **Acceptance.** Allow the Engineer access to in-progress work for QA review and testing.

1. **Field Inspection Acceptance**. Upon completion of work, schedule an inspection with the Engineer. The Engineer will note deficiencies, including areas exhibiting adhesion or cohesion failure. Reconstruct work identified by the Engineer as unacceptable.

504.04. Measurement and Payment

Pay Item	Pay Unit
Micro-Surface, Rutfilling	Ton
Micro-Surface	Square Yard
Micro-Surface, Single Cse	Square Yard
Micro-Surface, Longit	Foot

A. **General**. The unit prices for **Micro-Surface**, regardless of the type required, include cleaning existing pavement, applying a bond coat, placing temporary pavement markings, stationing, corrective action, and traffic control to complete corrective action.

B. **Micro-Surface Rutfilling.** The Engineer will measure **Micro-Surface, Rutfilling** based on the dry weight of fine aggregate in the mix. The unit price for **Micro-Surface, Rutfilling** includes placing mix over each wheel rut to create full-lane coverage.

C. **Micro-Surface.** The unit price for **Micro-Surface** includes all material, equipment, and labor for preparing the surface, placing temporary pavement markings, placing the micro-surfacing mixture, and applying a leveling course, a surface course filling shoulder, or centerline corrugations, or all, for full-width coverage as specified in the contract.

D. **Micro-Surface, Single Course.** The unit price for **Micro Surface, Single Cse** includes all material, equipment, and labor for preparing the surface, placing temporary pavement markings, placing the micro-surfacing mix, filling shoulder or centerline corrugations, and applying a single course of mixture for full-width coverage as specified in the contract.

E. **Micro-Surface, Longitudinal.** The unit price for **Micro-Surface, Longit** includes all material, equipment, and labor for preparing the surface and placing the micro-surfacing mixture at the width specified in the contract.

F. **Pavement Marking Removal.** The Department will pay separately for removing pavement markings in accordance with subsection 812.04.

Section 505. Chip Seals

505.01. Description

This work consists of the surface preparation and application of a single chip seal, a double chip seal, or shoulder chip seal.

505.02. Materials

Provide materials in accordance with the following sections:

Coarse Aggregate, 34CS, CS-T 902
Asphalt Emulsion, CSEA, CRS-2M 904

The Department will waive the AWI requirement on shoulders or when used as an interlayer.

For jobs north of M-46 with ADT <5,000 or any job where the chip seal is being used as an interlayer, CRS-2M is an approved alternate.

505.03. Construction

A. **Equipment.** Provide equipment capable of producing and placing a product meeting the requirements of this section.

1. **Pressure Distributor**. Provide a pressure distributor with a computerized application rate and speed control, capable of maintaining the asphalt emulsion at the temperature required by the contract. Ensure that the control has a radar ground-sensing device that controls the application rate regardless of ground speed and spray bar width. Ensure that the spray bar nozzles produce a uniform, triple-lap application fan spray, with instantaneous shutoff and no dripping. Ensure that each pressure distributor can maintain the required application rate within ±0.015 gallon per square yard for each load.

2. **Chip Spreader**. Provide a self-propelled chip spreader equipped with a computerized spread control, pneumatic tires, and a screen to remove oversized material.

3. **Compacting Equipment**. Provide at least three self-propelled pneumatic-tired rollers, each weighing at least 8 tons.

4. **Brooms**. Provide motorized brooming equipment, capable of cleaning the road surface before treatment and removing loose particles after treatment. Provide pick-up sweepers to clean road surfaces adjacent to lawns or roadways with curb and gutter.

5. **Pilot Car**. Provide a pilot car equipped with a sign that reads “Pilot Car — Follow Me” in accordance with MDOT Sign Standard G20-4. Mount the sign in a conspicuous position on the rear of the vehicle.

6. **Lights on Equipment**. Equip self-propelled equipment with at least one Department-approved, flashing, rotating, or oscillating amber light, visible in every direction. Equip chip spreaders with one light on each side of the spreader.

B. **Pre-Production Meeting.** Before beginning work, conduct an on-site pre-production meeting with the Engineer to discuss the following:

1. Review of the work schedule;

2. Examination of the traffic control plan;

3. Review of equipment calibration and adjustments;

4. Inspection of conditions of materials and equipment, including transport units;

5. Submission of the mix design, including JMF and a “Design for Intended Yield,” containing the aggregate gradation, Los Angeles (LA) abrasion resistance, loose unit weight, and application rate of asphalt emulsion and aggregate;

6. Submission of test results for flat and elongated ratio. Collect samples from one of the following locations:

   a. The shipping face of the stockpile at the production source; or

   b. The job site stockpile;

7. Discussion of the QC plan;

8. Designation of the Contractor’s authorized representative; and

9. Provision of unit prices for use in determining price adjustments for asphalt emulsion and coarse aggregate.

C. **Weather and Seasonal Limitations**

1. **Weather Limitations**. Place the chip seal when pavement and ambient temperatures are at least 55°F. Do not place chip seal if air temperatures are forecast below 40°F within 24 hours of completing placement. Do not apply chip seals in foggy or rainy weather, or if the existing pavement temperature is equal to or greater than 130°F.

2. **Single Chip Seals and Shoulder Chip Seals Seasonal Limitations**. Place single chip seals and shoulder chip seals in accordance with the following:

a. From June 1 to August 15 in the Upper Peninsula;

b. From May 15 to September 1 in the Lower Peninsula north of M-46; and

c. From May 15 to September 15 in the Lower Peninsula south of M-46.

3. **Double Chip Seal Seasonal Limitations**. Place double chip seals in accordance with the following:

a. From June 1 to August 1 in the Upper Peninsula;

b. From May 15 to August 15 in the Lower Peninsula north of M-46; and

c. From May 15 to September 1 in the Lower Peninsula south of M-46.

D. **Placement Operation**

1. **Signing**. Post signs along the roadway reading “Loose Gravel,” Federal Highway Administration (FHWA) (W8-7), and mount a 35 mph speed plaque below the sign. Place the signs at no greater than ½-mile intervals throughout the length of the project.

2. **Protecting Utility Castings and Raised Pavement Markers**. Before beginning the chip seal operation, protect utility castings and raised pavement markers using other protective coverings approved by the Engineer. Remove the protective coverings before sweeping and opening to traffic.

3. **Preparing Pavement Surface**. Prepare the pavement surface to receive the chip seal. Remove cold plastic pavement markings using an abrasion method. Clean pavements requiring treatment with a motorized power broom to remove loose material. Use a hand broom to clean cracks and other areas inaccessible by power broom. Use pick-up sweepers adjacent to lawns or roadways with curb and gutter.

4. **Equipment Operation**. Operate vehicles and equipment involved in the chip sealing as close together as possible. Spread the aggregate to cover the asphalt emulsion within 30 seconds of application. Do not allow the chip spreader to trail the emulsion distributor by more than 150 feet.

5. **Dust Control.** During normal traffic operations, wet broom, or lightly fog seal the roadway to control dust, as required by the Engineer. If dusty conditions continue, pre-coat the aggregate. Pre-coat the aggregate with 0.75%, by mass, residual asphalt.

The Contractor may perform pre-coating in a weight-batch type, continuous mixing type, or drum-type hot mix plant, using PG 64-22 asphalt binder or CSS-1h emulsion.

6. **Loose Stone**. During normal traffic operations, damage to motorists' vehicles due to loose stone picked up off the surface is not acceptable. Broom or fog seal the roadway until the condition is eliminated.

7. **Bleeding or Flushing**. During normal traffic operations, bleeding or moderate flushing is not acceptable. Sand and sweep the roadway to eliminate bleeding or moderate flushing. If sanding and sweeping do not eliminate bleeding or moderate flushing, apply, roll, and broom a heated aggregate with the physical properties specified in Table 902-8.

8. **Longitudinal Construction Joints**

   a. **Longitudinal Construction Joints in Single Chip Seal**. Where corrugations are not present, construct longitudinal construction joints in single chip seal to coincide with painted lane lines or at the outside edge of the shoulder. Where corrugations are present, construct joints at the outside edge of the far side of the corrugation on the first pass.

   b. **Longitudinal Construction Joints in Double Chip Seal**. Where corrugations are not present, construct longitudinal construction joints in the first course of a double chip seal to overlap the painted lane lines by 6 inches, and in the second course to coincide with the original painted lane line locations. Where corrugations are present, construct joints at the outside edge of the far side of the corrugation on the first pass. Construct joints at the outside edge of the opposite side of the corrugation for the second application.

   c. **Longitudinal Construction Joints in Shoulder Chip Seal**. Construct the longitudinal construction joint in shoulder chip seal at the edge of the driving lane or at a location requiring a minimal overlap without extending onto the driving lane.

9. **Roll the Aggregate After Spreading**. Allow no more than 2 minutes between the spreading of aggregate and completion of initial rolling. Use the rollers in a longitudinal direction at a speed no greater than 5 mph. Ensure that each roller travels over the aggregate three times with the final pass in the direction of the chip spreader.

10. **Sweeping After Placement**. After chip seal placement, perform an initial sweep of the construction traffic control zone before opening to traffic. Allow a minimum waiting period of 30 minutes between

application of the chip seal and initial sweeping. Additional sweeping to remove loose stones after opening to traffic will be required as determined by the Engineer. The Contractor may use an arrow board, in bar mode, pulled behind a vehicle trailing the sweeping equipment. Conduct sweeping so loose aggregate does not migrate back onto the pavement. Use a pick-up sweeper to remove loose aggregate adjacent to guardrails, lawns, curbs, curbed driveways, and curbed intersections.

11. **Cure Time and Repairs.** For double chip seals, wait at least 24 hours between completion of the first course and application of the second course.

    Do not allow traffic on the new surface until it cures. Repair traffic damage to the new chip seal surface at no additional cost to the Department.

    Grind the surface and lightly apply a fog seal to eliminate bumps or poor riding surfaces caused by transverse or longitudinal construction joints from the chip seal application.

    Readjust the spray bar and nozzles if longitudinal grooves or ridges in the surface cause an asymmetric appearance.

E. **Application Rates.** Apply the asphalt emulsion followed by a uniform application of coarse aggregate.

   Notify the Engineer immediately if the coarse aggregate gradation, or existing pavement surface conditions, necessitate an adjustment to the JMF target rate. Document the new JMF rates by stationing.

   1. **Asphalt Emulsion**

      a. **Single Chip Seal**. Apply asphalt emulsion from 0.39 gallons per square yard to 0.46 gallons per square yard. Apply the asphalt emulsion at a temperature from 170°F to 190°F.

      b. **Double Chip Seal**. Apply asphalt emulsion from 0.28 gallons per square yard to 0.32 gallons per square yard for the top course. Apply the first course as a single chip seal according to 505.03.E.1.a.

   2. **Coarse Aggregate**

      a. **Single Chip Seal**. Apply coarse aggregate from 20 pounds per square yard to 24 pounds per square yard.

      b. **Double Chip Seal**. Apply coarse aggregate from 16 pounds per square yard to 20 pounds per square yard for the top course.

Apply the first course as a single chip seal according to 505.03.E.2.a.

F. **Documentation**

1. **Daily Report**. Submit a daily report to the Engineer with the following information:
    a. Control section;
    b. Project number;
    c. County;
    d. Route;
    e. Engineer;
    f. Date;
    g. Detailed weather information;
    h. Pavement temperature;
    i. Asphalt emulsion application temperature;
    j. Beginning and ending stations (placement and brooming);
    k. Notification of mix design change;
    l. Aggregate gradation and moisture content (at least one per day); and
    m. Signature of the Contractor's authorized representative.
2. **Miscellaneous.** Document the following as required:
    a. Load tickets for coarse aggregates and asphalt emulsion; and
    b. Changes in the design to the intended yield.

G. **Quality Control.** If the Engineer identifies conditions that cause an unsatisfactory chip seal, immediately stop production and begin corrective action, at no additional cost to the Department. Maintain QC measures until the Engineer accepts the work.

1. **Quality Control Plan.** Establish and maintain an effective QC plan. Ensure that the QC plan details the procedures and organization to produce the required single, double, and shoulder chip seal operations. Provide the Engineer with a copy of the QC plan for review and approval, prior to the pre-production meeting. Comply with the Engineer-approved QC plan for the duration of the project and allow the Engineer access to in-progress work for QA review and testing.

Ensure that the QC plan addresses at least the following:

a. Materials;

b. Sampling and testing methods to determine compliance with material specifications;

c. Equipment;

d. Calibration method to determine compliance with the application rates;

e. Procedures for pavement cleaning and preparation;

f. Controls implemented to ensure the chip seal material cures or sets up before opening to traffic;

g. Proposed procedure for monitoring initial acceptance requirements;

h. Dust control;

i. Bleeding;

j. Rough joints;

k. Surface patterns;

l. Procedures to ensure that both the initial and final sweeping are completed in a manner that prevents damage to vehicles; and

m. An action plan, demonstrating how the chip seal operation will be adjusted for adverse environmental conditions.

2. **QC Sampling and Testing**. Perform the following minimum QC tests during chip seal placement.

   a. **Coarse Aggregate.** Determine the actual application rate by placing a tarp over 1 square yard of pavement, applying coarse aggregate to the pavement in a production run, retrieving the aggregate placed on the tarp, and weighing the coarse aggregate.

      Collect one sample from the project aggregate stockpile each day of production and perform a sieve analysis. Ensure that the sieve analysis results meet the requirements of Table 902-7 and fall within the QC tolerances of Table 505-1 to substantiate the design for intended yield.

   b. **Emulsion**. Determine the actual application rate using a 1,000-foot yield check.

Table 505-1:
Chip Seal Quality Control Tolerances

Parameter	Tolerance
⅜ inch sieve	−5.0%
No. 4 sieve	+5.0%
Aggregate application rate	±1 pound per square yard of the required JMF application rate
Emulsion application rate	±0.01 gallon per square yard of the JMF target rate

H. **Acceptance**

1. **Field Inspection Acceptance**. Upon completion of work, schedule an inspection with the Engineer. The Engineer will note deficiencies, including areas exhibiting adhesion failure, cohesion failure, excessive stone, loss of stone, or other factors the Engineer identifies as unacceptable. Correct work the Engineer determines unacceptable.

2. **Delayed Acceptance**. At least 30 days after placing the single chip seal, double chip seal, or shoulder chip seal, the Engineer, with the Contractor, will inspect the project for surface flushing, surface patterns, or loss of stone. If the Engineer determines the work includes these deficiencies, correct the work within 9 days of the review, or by an agreed upon date, and at no additional cost to the Department.

505.04. Measurement and Payment

Pay Item	Pay Unit
Seal, Single Chip	Square Yard
Seal, Double Chip	Square Yard
Seal, Shld Chip	Square Yard

A. **Price Adjustment.** The Department will not make adjustments in the unit price for chip seal if the specified application rates for asphalt emulsion and coarse aggregate are within the specified ranges.

The Department may make an adjustment for an Engineer-approved revision to the application rates of asphalt emulsion and coarse aggregate, if the rates are outside of the specified ranges. The Department will limit the unit price adjustment to the material costs outside the specified ranges.

Provide unit prices for use in determining price adjustments for asphalt emulsion and coarse aggregate at the pre-construction meeting.

B. **Seal, Single Chip.** The unit price for **Seal, Single Chip** includes the cost of placing a single application of asphalt emulsion and coarse aggregate to a pavement and the accompanying shoulders, material sampling and testing, surface preparation, brooming, and documentation.

C. **Seal, Double Chip.** The unit price for **Seal, Double Chip** includes the cost of placing a double application of asphalt emulsion and coarse aggregate to a pavement and the accompanying shoulders, material sampling and testing, surface preparation, brooming, and documentation.

D. **Seal, Shoulder Chip.** The unit price for **Seal, Shld Chip** includes the cost of placing a single application of asphalt emulsion and coarse aggregate to shoulders, material sampling and testing, surface preparation, brooming, and documentation.

E. **Pavement Marking Removal.** The Department will pay separately for removing pavement markings in accordance with subsection 812.04.

Section 506. Slurry Seal

506.01. Description

This work consists of preparing the surface and applying a slurry seal mixture.

506.02. Materials

Provide material in accordance with the following sections:

Type I Portland Cement 901
Fine Aggregate, 2FA 902
Asphalt Emulsion, CSS-1h 904
Water 911

The Engineer will waive the cement mixing test for Asphalt Emulsions, CSS-1h.

A. **Mix Design Requirements.** Provide a slurry seal mix consisting of asphalt emulsion, fine aggregate, portland cement, water, and other additives. The mixture must be designed by a Department-approved laboratory. Mix additives may be used to provide additional control of the quick set properties and to increase adhesion. List additives as part of the mix design. Submit the mix design to the Engineer at least 14 days before beginning construction.

   Submit a new mix design for any change in aggregate or asphalt emulsion sources.

   Verify the compatibility and proportions of the fine aggregate, asphalt emulsion, portland cement, and additives.

   From the mix design, develop a JMF showing the proportions of each material. The JMF must comply with ASTM D3910 for consistency, set time, cure time, and wet track abrasion.

   Design a JMF with a residual asphalt binder content from 9.0% to 11.0% of the aggregate dry weight, and with a cement content from 0.5% to 3.0% of the aggregate dry weight.

   1. **Mix Design Documentation**. Include all of the following in the mix design:

      a. Sources of individual materials;

      b. Aggregate properties including gradation, sand equivalence, and angularity index;

c. Test results for the following parameters as tested in accordance with ASTM D3910:

   i. Consistency test;

   ii. Set time;

   iii. Cure time; and

   iv. Wet track abrasion;

d. Interpretation of results and determination of a JMF including the following:

   i. Cement (minimum and maximum), percent;

   ii. Water, including aggregate moisture (minimum and maximum), percent;

   iii. Additive (if required), percent;

   iv. Emulsion in mix, percent;

   v. Residual asphalt content of emulsion; and

   vi. Residual asphalt content in mix, percent.

e. Mix designer's signature and date.

506.03. Construction

A. **Equipment.** Provide equipment capable of producing a specification product.

1. **Slurry Seal Mixer**. Provide a continuous-flow slurry seal mixing machine with automated controls capable of delivering predetermined proportions of aggregate, water, and asphalt emulsion to the mixing chamber and capable of continuously discharging the mixed product. Do not mix violently. Equip and operate each mixing machine with the following:

   a. Easy-to-read metering devices that accurately measure the raw materials before they enter the pugmill;

   b. System to pre-wet the aggregate in the pugmill immediately before mixing with the emulsion;

   c. Fines feeder with a metering device, or other approved means, to drop the required mineral filler quantity onto the aggregate before entering the mixing machine. Use the fines feeder if mineral filler is part of the aggregate blend;

d. Water pressure system and a fog-type spray bar to fog the surface immediately ahead of the spreading equipment;

e. Capability of operating at a speed of at least 60 feet per minute, and it must be operated at less than 180 feet per minute;

f. Storage capacity to mix at least 7 tons of slurry seal; and

g. Method of measuring materials in each slurry seal batch. Obtain the Engineer's approval of the measurement method and make available for observation.

Check the slurry seal mixer weekly to ensure that the condition of the equipment meets requirements.

2. **Spreading Equipment.** Attach an adjustable, mechanical-type single squeegee distributor to the mixing machine. Equip the distributor with flexible material in contact with the road surface to prevent loss of slurry. Provide a steerable distributor, adjustable in width with a flexible strike-off capable of applying a uniform application of slurry on varying grades and crowns.

   The spreader box must not leave grooves in the slurry. Keep the spreader box clean, and do not allow material build-up on the spreader.

   Obtain the Engineer's approval of burlap, or other textile drag. Wet the drag with water at the beginning of each application. Clean or change the drag as directed by the Engineer.

3. **Calibration Requirements**. Before construction, calibrate each slurry seal mixer in accordance with the Asphalt Institute's Manual Series. Submit documentation of the calibration of each material metering device at various settings. Supply materials and equipment, including scales and containers, for calibration. After calibrating each mixing machine, demonstrate the ability of the machine to mix components together to simulate an end product. Repeat mixer calibration for changes in aggregate or asphalt emulsion source.

4. **Miscellaneous Equipment**. Provide hand squeegees, shovels, and other equipment to perform the work. Provide cleaning equipment including power brooms, air compressors, water flushing equipment, and hand brooms for surface preparation.

5. **Lights on Equipment**. Equip power brooms, distributors, and truck-mounted spreaders and mixers with at least one Department-approved, flashing, rotating, or oscillating amber light, visible in every direction. Equip continuous mixer and spreader units with one light on each side of the machine.

B. **Pre-Production Meeting.** Before beginning work, conduct an on-site pre-paving meeting with the Engineer to discuss the following:

1. Contractor's detailed work schedule;
2. Traffic control plan;
3. Equipment calibration;
4. Mix design previously submitted to the Engineer;
5. Equipment inspection, including transport units;
6. Surface preparation and pre-treatment; and
7. Availability of materials.

C. **Surface Preparation.** Remove loose material, vegetation, dirt, mud, and other deleterious materials, and wash animal remains from the surface before placing the slurry seal. Before placing slurry seal, treat visible cracks with overband crack fill in accordance with section 502.

If a bond coat is required, use one part CSS-1h emulsified asphalt to three parts water and apply at a rate of 0.05 gallons per square yard. Allow the bond coat to cure before placing the slurry seal.

Apply water fog from 0.03 gallon per square yard to 0.06 gallon per square yard.

D. **Application.** Apply a single course of slurry seal over the area shown on the plans at a rate of at least 16 pounds per square yard, based on the weight of dry aggregate.

E. **Surface Quality.** Provide a finished surface, free of scratch marks, rippling, and other surface irregularities. Do not leave tear marks greater than ½ inch wide and 4 inches long, or other marks greater than 1 inch wide and 1 inch long.

F. **Cure Time and Repair.** Do not allow traffic on the new surface until it cures. Repair traffic damage to the new slurry seal surface at no additional cost to the Department.

G. **Weather and Seasonal Limitations**

1. **Weather Limitations**. Place the slurry seal when pavement and ambient air temperatures are at least 45°F and are rising. Do not place mix in rain or inclement weather, or if temperatures are forecast below 32°F within 24 hours of application.
2. **Seasonal Limitations**. Place slurry seal in accordance with the following seasonal limitations:

a. From June 1 to September 15 in the Upper Peninsula; or

b. From May 1 to October 1 in the Lower Peninsula.

H. **Quality Control.** If the Engineer identifies conditions that cause an unsatisfactory slurry seal, immediately stop production and begin corrective action, at no additional cost to the Department. Maintain QC measures until the Engineer accepts the work.

Produce a mix that meets the JMF and the QC tolerances specified in Tables 506-1 and 506-2. Notify the Engineer immediately and stop mix production if the QC test results exceed the tolerance specified in Tables 506-1 and 506-2. Identify the cause of the deviation and determine the corrective action necessary to bring the mix into compliance. Obtain the Engineer's approval before resuming work.

Table 506-1:
Slurry Seal Quality Control Tolerances

Sieve Size	Tolerance
No. 4	±5.0%
No. 8	±5.0%
No. 16	±5.0%
No. 30	±5.0%
No. 50	±4.0%
No. 100	±3.0%
No. 200	±2.0%

Table 506-2:
Slurry Seal General Quality Control Tolerances

Parameter	Tolerance
Asphalt cement content single test	±0.5% from JMF
Asphalt cement content daily average	±0.2% from JMF

1. **Sampling and Testing**. Conduct QC sampling and testing at the following minimum frequency:

a. Randomly sample fine aggregate from the mixer and test for gradation at a rate of one test per 500 tons of aggregate. Conduct at least one test per day of mix production.

b. Randomly, at least three times per day, calculate the percent asphalt content of the mixture using the equipment counter readings.

2. **Documentation**. Within 1 working day of mix production and placement, provide a daily report to the Engineer with the following information:

   a. Control section;

   b. Project number;

   c. County;

   d. Route;

   e. Engineer;

   f. Date;

   g. Air temperature;

   h. Control settings;

   i. Calibration values;

   j. Unit weight of emulsion (pounds per gallon);

   k. Percent residue in emulsion;

   l. Beginning and ending stations;

   m. Counter readings (beginning, ending, and total difference);

   n. Aggregates placed;

   o. Gallons of emulsion placed;

   p. Percent of each material;

   q. Percent of asphalt cement;

   r. Application rate;

   s. JMF (percent portland cement, percent emulsion, gradation, percent asphalt concrete);

   t. Contractor’s authorized signature;

   u. Calibration forms;

   v. Aggregate gradations; and

   w. Asphalt emulsion load ticket.

   If using truck-mounted machines, prepare a separate daily report for each machine.

I. **Acceptance**

1. **Field Inspection Acceptance**. Upon completion of work, schedule an inspection with the Engineer. The Engineer will note deficiencies, including areas exhibiting adhesion or cohesion failure, or other factors the Engineer determines unacceptable. Correct work identified by the Engineer as unacceptable.

2. **Delayed Acceptance**. At least 30 days after completion of the slurry seal, the Engineer will inspect the project for surface flushing and loss of material. If the Engineer finds these deficiencies, correct the work as approved by the Engineer within 9 days of the inspection, or other date, as agreed by the Engineer, and at no additional cost to the Department.

506.04. Measurement and Payment

Pay Item	Pay Unit
Seal, Slurry	Square Yard

The unit price for **Seal, Slurry** includes the cost of cleaning existing pavement surface, applying a bond coat, placing the mix, and traffic control, including traffic control to complete corrective action.

The Department will pay separately for overband crack fill pre-treatment, in accordance with subsection 502.04.